ANNUAL REPORT

GREAT LAKES FISHERY COMMISSION

1965

GREAT LAKES FISHERY COMMISSION

MEMBERS — 1965

CANADA	UNITED STATES
A. O. Blackhurst	D. L. McKernan
C. H. D. Clarke	Claude Ver Duin
A. L. Pritchard	Lester P. Voigt

SECRETARIAT

N. S. Baldwin, Executive Secretary
Robert Saalfeld, Assistant Executive Secretary
Edith McPherson, Secretary

GREAT LAKES FISHERY COMMISSION

Established by Convention
between Canada and the United
States for the Conservation of
Great Lakes Fishery Resources.

ANNUAL REPORT

FOR THE YEAR

1965

1451 Green Road
ANN ARBOR, MICHIGAN,
U. S. A.
1967

LETTER OF TRANSMITTAL

The Chairman of the Great Lakes Fishery Commission takes pleasure in transmitting to the Contracting Parties an Annual Report of the Commission's activities during 1965.

A. L. Pritchard, *Chairman*

CONTENTS

Dr. John Richardson Dymond, a member of the Great Lakes Fishery Commission since 1960, died on January 31, 1965, at the age of 77.

A scientist and educator of international reputation, J. R. Dymond was deeply concerned with the welfare of the Great Lakes fishery. He understood the difficulties in its administration, its purely biological problems, and the aspirations of those who depended on the fishery for their livelihood or used it for recreation. His opinions were, therefore, sought by many persons with different, often conflicting, interests. His advice and encouragement, for more than 50 years, helped develop a more rational approach to fishery management and research on the Great Lakes.

ANNUAL REPORT FOR 1965

INTRODUCTION

The Great Lakes Fishery Commission was established in 1955 by the Convention on Great Lakes Fisheries between Canada and the United States. The Commission is to formulate and coordinate research designed to determine measures needed to provide maximum sustained productivity of fish stocks of common concern, to recommend appropriate measures based on the results of this research, and to develop and implement a program to eradicate or minimize sea lamprey. In carrying out these duties, the Commission makes use of existing agencies. Control of the sea lamprey, which has been a major concern of the Commission since its establishment, has been carried out by contracts with the Fisheries Research Board of Canada and the U.S. Bureau of Commercial Fisheries.

Early attempts to control sea lamprey by blocking their spawning streams with mechanical and electrical barriers were discontinued in 1960 when it was found that chemically treating streams to destroy larvae was more effective. Treatments began in Lake Superior in 1958 and by the end of 1965 all lamprey streams, with the exception of a small tributary at the northern end, had been treated once and 74 streams two or more times to dispose of re-established populations. The lamprey catch at 24 barriers operated to follow changes in the population dropped sharply in 1962 to about 20 percent of the average catch for the preceding five years. The catch has remained at this level and possible sources for the residual population are being sought. Attention is presently focused on adult lamprey congregating in the fall below the locks connecting Lake Superior and Lake Huron. Lamprey collected here and at other locations in northwestern Lake Huron are being tagged to follow their movements and assess their contribution to populations in Lake Superior and Lake Michigan.

Since the reduction of lamprey in Lake Superior, the survival of lake trout has improved and older fish have become more abundant. In the fall of 1964, substantial numbers of mature lake trout were observed on spawning grounds in western Lake Superior and in 1965 naturally produced trout fingerlings were taken by experimental fishing for the first time since 1959. In order to expedite the recovery of the population, the annual

catch of lake trout in Lake Superior has been restricted to about 90,000 fish which are taken for biological information. Some lake trout populations on offshore grounds are approaching a state where they can soon support fishing operations on a moderate scale but inshore populations require continued protection until natural reproduction is re-established.

In Lake Michigan, 93 of 99 lamprey streams have been treated once and 18 streams twice since 1960. The catch of spawning lamprey at three assessment barriers has declined to about 30 percent of the average catch for the period 1958 to 1962. A recent marked improvement in the catch of whitefish may be related to the reduction in lamprey.

During 1965, surveys to locate lamprey streams and collect information for planning chemical operations were continued in Lake Huron, Lake Erie, and Lake Ontario. Research was also continued on chemicals or combinations of chemicals with potential as lampricides. Information on lamprey behavior which could improve operations was also collected. Where lamprey larvae have been studied intensively a minimum larval life of five years has been established and re-treatment at slightly longer intervals than previously believed necessary may be possible for most streams.

In 1965, the Commission established a number of committees in order to consider in greater detail problems and programs not directly associated with lamprey control. One committee was formed to deal with sea lamprey control and research, and a second committee established to deal with management and general research. The latter includes representatives from five lake committees organized by the Commission to deal more effectively with local problems. The lake committees are composed of senior representatives from the agencies administering the fishery assisted by scientists from their own or other agencies engaged in biological research or in providing technical assistance to the fishing industry. The development and coordination of research and management on each lake will be largely carried out through these committees.

1965

ANNUAL MEETING

AGENDA

1. Call to order
2. Introductions
3. Adoption of agenda
4. News release on meeting
5. Report of Chairman
6. Approval of Minutes of Interim Meeting
7. Consideration and adoption of changes in Commission Rules of Procedure to establish committees, as proposed at the Interim Meeting, 1964
8. Consideration of sea lamprey control and research
9. Consideration of management and research
10. Report of Scientific Advisory Committee
11. Administrative matters
12. Time and place of next meeting
13. Adjournment

ANNUAL MEETING

PROCEEDINGS

The Tenth Annual Meeting of the Great Lakes Fishery Commission was held in Ann Arbor, Michigan on June 22-24, 1965.

Call to order. Mr. Donald McKernan, Chairman of the Commission, called the meeting to order and introduced the Commissioners. Advisors from Canada and the United States were introduced by Dr. A. L. Pritchard and Mr. L. P. Voigt.

The Chairman drew attention to the death of Commissioner J. R. Dymond on January 31, 1965 and described the many ways in which he had helped advance fishery science, particularly in the Great Lakes. The Commission adopted a resolution acknowledging his outstanding contribution and expressing its deep sense of loss.

Adoption of agenda. The tentative agenda circulated prior to the meeting was adopted after several minor changes.

Press relations. The preparation of news releases on the meeting was assigned to the Management and Research Committee assisted by Commission's staff and a representative of the University of Michigan News Service.

Report of Chairman. In his opening remarks, the Chairman drew attention to the close cooperation which had developed between the two countries in adopting measures to improve the Great Lakes fishery. Cooperation among agencies, particularly those carrying out the Commission's lamprey control program, was especially gratifying and undoubtedly contributed to the favorable results. Lampreys were reduced, and lake trout, aided by a well planned and carefully executed planting program, were at almost normal levels in some areas of Lake Superior. Promising results were forecast for Lake Michigan where most of the lamprey streams had been treated. During the meeting the Commission would consider extending treatments to Lake Huron and carrying out surveys of Lake Erie and Lake Ontario streams to determine the extent and cost of sea lamprey control in these lakes.

The Chairman reminded the Commission that in 1964 it had recommended a broad program of investigations for the Great Lakes fishery. Now it must encourage development of the program. With this purpose in mind, the Commission had established

a number of committees to determine the investigations required on the lakes individually and collectively and then develop the appropriate research programs.

The Chairman stated that the deterioration of the fishery in Lake Erie was a major concern. Investigations had barely been able to follow the changes in its fish populations leaving little opportunity for the detailed studies needed to determine the causes. The discharge of industrial and domestic wastes was believed to play an important role in the biological changes. If so these changes would continue until pollution was substantially reduced. Both research and management of the fishery should be considered against this background.

Approval of Minutes of Interim Meeting. Minutes of the Interim Meeting, held in Washington, D. C. on December 2-3, 1964, were approved.

Consideration of revisions in Rules of Procedure. The Commission approved the deletion of part (j) of Rule 14, and adopted revised Rules 16 and 17 as follows:

Rule 16 (revised)

A position of Assistant Executive Secretary shall be established. Such person shall be engaged by the Executive Secretary subject to the approval of the Commission. Among his duties will be the coordination of investigations and operations by agencies engaged in research on and restoration of lake trout conducted at the request of the Commission.

Rule 17 (revised)

(a) There shall be four standing committees:

(i) A *Finance and Administration Committee* shall consist of one Commissioner from each national section, and one or more experts or advisors selected by each national section. The Committee shall advise the Commission on matters pertaining to the Commission's accounts, budgets, publications, meetings, and other fiscal or administrative matters referred to it by the Commission.

(ii) A *Scientific Advisory Committee* shall consist of one Commissioner from each national section and three scientist members from each Contracting Party, who may be assisted by experts and advisors. The Committee shall advise the Commission on such matters relating to lamprey control and research and general fishery research as the Commission may submit to it.

(iii) A *Sea Lamprey Control and Research Committee* shall con-

sist of one Commissioner from each national section, a member from each of the Commission's agents, a member from each agency cooperating in the sea lamprey program, and experts or advisors selected by each national section. The Committee shall advise the Commission on the progress of sea lamprey control and research, plans and budgets for this activity, and other related matters referred to it by the Commission.

(iv) A *Management and Research Committee* shall consist of one Commissioner from each national section, the Chairmen and Vice-Chairmen of committees established for each of the Great Lakes as provided under 17(b), and one federal representative from the United States and Canada. It may be assisted by experts and advisors. The Committee shall advise the Commission on the status and problems of the fisheries, both commercial and sport, progress and adequacy of research, significant findings, measures to improve the productivity of the fisheries, and other management or research matters referred to it.

(b) There shall be a lake committee established for each of the Great Lakes. Each committee shall consist of a senior staff member from each agency administering the fishery, assisted by experts and advisors from all agencies concerned. These committees shall develop and coordinate studies and encourage the implementation of their findings, and consider other management or research matters referred to it by the Commission through the Management and Research Committee.

(c) The Commission may, from time to time, establish temporary committees or sub-committees as it desires.

(d) The Chairman of each committee authorized under 17(a) shall be a Commissioner who will hold office for two years. Chairmanship shall alternate biennially between national sections. The Chairman of the Scientific Advisory Committee may call on a Convenor, selected by the Commission, to conduct the Committee's scientific deliberations.

Consideration of sea lamprey control and reasearch. The Commission, after receiving a report on the progress of the sea lamprey program from its Sea Lamprey Control and Research Committee, asked that:

a. its agents carrying out the program arrange a joint meeting to evaluate procedures and techniques for using the synergist (Bayer 73) with the lampricide (TFM);

b. the Canadian agent assess the significance of possible sources of sea lamprey recruitment in Canadian waters of Lake Superior;

c. the Canadian agent reconsider the need for annual re-treatment of Batchawana Bay tributaries and if it believed these should be continued, give its reasons at the Interim Meeting;

d. the United States agent discontinue the operation of assessment barriers on the east shore of Lake Michigan and forego the construction of two barriers on the west shore of Lake Huron in fiscal year 1965-66;

e. the Canadian agent reduce its survey and barrier construction program in Lake Huron in fiscal year 1965-66 insofar as possible to partially meet a reduction in appropriations to the Commission program;

f. the United States agent also reduce surveys, particularly on Lake Erie and Lake Ontario, to reduce operational costs in fiscal year 1965-66.

The Commission adopted a program for fiscal year 1966-67 calling for the following activities:

Lake Superior—Re-treat 26 streams (11 in Canada and 15 in the United States); keep under surveillance potential lamprey streams; follow the re-establishment of larval populations in treated streams to determine when re-treatment was necessary; operate barriers on 16 United States streams and 8 Canadian streams to follow changes in lamprey abundance.

Lake Michigan—Re-treat 25 streams; continue surveillance of potential lamprey streams; follow re-establishment of larvae; and operate assessment barriers on 3 Green Bay streams.

Lake Huron—Treat 22 lamprey streams in northeastern Lake Huron; continue survey to locate new lamprey streams; and operate assessment barriers on 14 streams to assess lamprey abundance before treatments take effect.

Lake Erie and Lake Ontario—Survey streams on the south shores of Lake Erie and Lake Ontario to determine those producing lamprey and collect information useful in planning chemical treatments.

Research—Continue laboratory investigations of salicylanilide compounds with potential as lampricides and as synergists with various nitrophenols; determine exposure to TFM which will cause irreversible damage and ultimately death; study reaction of lamprey to lowered stream level; investigate growth and transformation of larval lampreys in relation to population density; investigate the effects of water chemistry and water temperature on the effectiveness of TFM; and follow changes in fauna of streams treated repeatedly with lampricide.

Consideration of management and research. The Commission accepted the report of the Management and Research Committee and after considering its recommendations agreed

to: (1) enlarge the membership of the Committee to include one federal government representative from each country; and (2) recommend additional fishing on certain offshore stocks of lake trout to determine their response to increased fishing pressure.

The Commission asked that the Lake Superior Committee determine what increase in lake trout fishing should be allowed, how it should be distributed, and when it should begin. The Committee was also asked to investigate the desirability and feasibility of increasing lake trout stocking rates in Michigan and Ontario waters of Lake Superior to expedite rehabilitation. The Commission asked the Lake Michigan Committee to develop cooperative studies to evaluate lake trout rehabilitation in Lake Michigan as quickly as possible.

The Commission agreed to consider the establishment of an *ad hoc* committee to consider ways of mitigating conflicts between commercial and sport fishing interests as suggested by the Management and Research Committee. Commissioner members were asked to define objectives and terms of reference which the Commission could study.

Report of Scientific Advisory Committee. The Commission accepted the report of the Scientific Advisory Committee (summarized on page 60).

Administrative matters. The Commission, in response to a request from the contracting governments for an economic study of sea lamprey control and lake trout rehabilitation, approved a project to establish a model for analyzing the economic consequences of lamprey control and alternatives in relation to their cost. The Commission approved the retention of an economist and biologist from each country as consultants to make the study.*

Time and place of next meeting. The Commission agreed to hold the 1965 Interim Meeting on November 30-December 1, 1965 at Toronto, Ontario.

Adjournment. The Chairman expressed the Commission's appreciation for the interest shown and assistance given by those attending and adjourned the 10th Annual Meeting at 2:00 p.m., June 24th.

*Dr. Ayers Brinser, School of Natural Resources, The University of Michigan.
Mr. H. C. Frick, Economics Service, Department of Fisheries, Ontario.
Dr. F. E. J. Fry, Department of Zoology, University of Toronto.
Dr. L. L. Smith, Department Entomology, The University of Minnesota.

ANNUAL MEETING

ATTENDANCE

Officers

Chairman: D. L. McKernan
Vice Chairman: A. L. Pritchard

MEMBER GOVERNMENTS

CANADA

Commissioners:
A. O. Blackhurst
A. L. Pritchard

Scientific Advisors:

D. M. Brooks	J. W. Lockwood
E. W. Burridge	K. H. Loftus
M. J. Brubacher	F. P. Maher
W. J. Christie	J. D. Roseborough
R. G. Ferguson	G. F. M. Smith
H. C. Frick	J. J. Tibbles
F. E. J. Fry	W. H. R. Werner
W. A. Kennedy	

UNITED STATES

Commissioners:
D. L. McKernan
Claude Ver Duin
L. P. Voigt

Advisors:
D. J. Curry
R. H. Full
W. J. Harth
R. A. Jensen
J. H. Kitchel
Richard Kotis
W. M. Lawrence
D. J. Leedy
S. S. Sivertson
G. E. Sprecher
H. O. Swenson
G. L. Trembley
H. M. Woods

Scientific Advisors:

Ayers Brinser	C. N. Lloyd	
W. F. Carbine	A. L. McLain	
G. P. Cooper	J. V. Manz	
W. R. Crowe	J. W. Moffett	
C. A. Dambach	P. R. Nelson	
John Emerson	R. L. Pycha	
L. F. Erkkila	Edw. Schneberger	
P. H. Eschmeyer	L. L. Smith	
Wm. Gordon	S. H. Smith	
Ralph Hile	T. M. Stauffer	
J. H. Howell	H. A. Tanner	
Walter Jones		

Observers:

D. C. Chandler	J. G. McKevitt	G. W. Piavis	R. J. Starkey
L. J. Goodsell	E. D. Premetz	J. A. Slater	H. F. Weekley

SECRETARIAT

N. S. Baldwin, *Executive Secretary*
R. W. Saalfeld, *Asst. Executive Secretary*

INTERIM MEETING

The Commission held an Interim Meeting in Toronto, Ontario on November 30-December 1, 1965. Reports on the progress of sea lamprey control, lake trout rehabilitation and the introduction of exotic species were presented. The Commission reviewed the program for lamprey control in fiscal year 1966-67 and considered several recommendations from the Lake Superior Committee. An outline of plans for an economic study of cost and benefits of sea lamprey control and lake trout rehabilitation was submitted by a group of consultants retained by the Commission.

Progress of sea lamprey control. The Commission's agents submitted reports on the progress of sea lamprey control since the Annual Meeting and provided special reports on treatment of the Brule River, possible sources of lamprey recruitment in Canada, and the need for annual treatment of Batchawana Bay tributaries.

The report on the treatment of the Brule by the Bureau discounted the possibility that this river might have been a major contributor to the lamprey populations remaining in the lake. The Canadian agent believed that lamprey missed in regular treatments and lake-dwelling ammocetes in Batchawana Bay could account for the adult lamprey still being taken. Although annual treatment of three Batchawana Bay streams had reduced larvae off their mouths survivors in the bay appeared to be reentering the estuaries and should be destroyed before they could contribute to the adult population. Failure of the adult populations to continue to decline in Lake Superior might also be due to the entrance of lamprey from Lake Huron.

Lake trout rehabilitation. The Commission was advised that the catch of young unmarked lake trout near Gull Island Shoal in Wisconsin waters of Lake Superior was the first indication of successful natural spawning in the area since 1959. A few unmarked young trout taken inshore suggested that spawning had been successful there also.

The Commission adopted a recommendation from the Lake Superior Committee that the lake trout catch quotas for the four jurisdictional areas in 1966 remain the same as in 1965. The Committee agreed to present detailed proposals for intensifying fishing in 1967 on certain populations to assess their ability to support a fishery. The Committee would also report to the

Commission on the desirability of increasing lake trout plantings in Michigan and Ontario waters of Lake Superior following a joint meeting with the Lake Michigan Committee to be held in March 1966 to discuss the most effective disposition of hatchery lake trout. The Commission asked that the Scientific Advisory Committee and Committees for the three upper lakes provide it with long range plans for planting lake trout and splake.

The Commission was advised that several agencies now required anglers to have permits to fish for lake trout in Lake Superior and report their catch. The Management and Research Committee was asked to continue to study methods of obtaining reliable sport catch statistics.

The Lake Michigan Committee reported that it had arranged for a systematic sampling of the commercial fishery to obtain information on young lake trout planted in Lake Michigan. The State of Michigan was outfitting a small research vessel to cover inshore areas not fished commercially. Additional information would come from exploratory fishing of the *Kaho* and biological investigations of the *Cisco*, two vessels operated by the Bureau of Commercial Fisheries. The incidental catch of planted fish would be investigated and if this proved significant ways of reducing losses would be studied. As major sport fisheries for lake trout developed, methods for sampling the angler catch would be tested.

Introduction of exotics. Representatives from the Ontario Department of Lands and Forests and Michigan Department of Conservation described progress and plans for introducing kokanee. About 1.5 million eggs and fry had been planted in Canadian tributaries and at shore sites in Lake Ontario and Lake Huron. Michigan had planted 2.8 million fry in two inland lakes to establish brood stocks. Plantings would continue for four years. Michigan had obtained coho (silver) salmon eggs from Oregon and planned to plant about 0.8 million yearlings in one Lake Superior and two Lake Michigan rivers in the spring of 1966.

Program and budget for fiscal year 1966-67. The Commission was advised that there would be a substantial reserve of lampricide at the end of fiscal year 1965-66 since it had not been necessary to treat the main stems of the Grand and St. Joseph Rivers. Part of the chemical required in the next year could be drawn from this reserve. Estimates for sea lamprey control in fiscal year 1966-67 had, therefore, been reduced from $1,819,000 to $1,607,100, an increase of $110,800 over the budget for fiscal

year 1965-66. The Commission, after expressing concern that failure to deal with lamprey streams on Lake Huron might reduce effectiveness of control in Lake Michigan and Lake Superior, agreed that if the increase requested was not granted, treatments should nevertheless be extended to as many lamprey streams in northwestern Lake Huron as possible.

ADMINISTRATIVE REPORT FOR 1965

Officers and staff. There were no changes in the officers of the Commission during 1965. However, additional responsibilities were placed on all its members by the formation of three committees to which Commissioners were assigned as follows:

Sea Lamprey Control and Research Committee

L. P. Voigt (Chairman)
C. H. D. Clarke

Management and Research Committee

Claude Ver Duin (Chairman)
A. O. Blackhurst

Scientific Advisory Committee

A. L. Pritchard (Chairman)
D. L. McKernan

The additional services required by these committees and more particularly the committees established on each of the lakes has made it necessary to employ a second secretary, Mrs. T. C. Woods.

Accounts and audit. The Commission's accounts for FY 1964-65 were audited by Icerman, Johnson and Hoffman, Ann Arbor. Their report is appended.

Contributions to the 1964-65 program. The Commission approved its program for FY 1964-65 in July 1963, then revised it at the Interim Meeting in December. It requested $1,552,600 for Sea Lamprey Control and Research and $49,000 for Administration and General Research. An appropriation of $1,030,700, or $65,100 less than requested was approved by the United States in August 1964. After a reduction in the Canadian contribution to maintain the cost sharing formula, funds available for Sea Lamprey Control and Research were $1,458,260.

Requests for funds, credits for underexpenditures, and contributions for fiscal year 1964-65 were as follows:

	Canada	*United States*	*Total*
Sea lamprey control and research			
Commission request	$481,300	$1,071,300	$1,552,600
Appropriations	452,060	1,006,200	1,458,260
Credits-FY 1962-63	1,458	3,246	4,704
	$450,602	$1,002,954	$1,453,556
Administration and general research			
Commission request	$ 24,500	$ 24,500	$ 49,000
Appropriation	24,500	24,500	49,000
Credits-FY 1963-64	1,687	1,686	3,373
	$ 22,813	$ 22,814	$ 45,627

Expenditures in FY 1964-65. Agreements to carry out the program in FY 1964-65 were made with the Fisheries Research Board of Canada ($374,900 Canadian dollars) and the U.S. Bureau of Commercial Fisheries ($792,250 U.S. dollars). The Commission also entered into contracts ($10,000) with a group of consultants to develop a plan for an economic study of the benefits of sea lamprey control and lake trout rehabilitation, as requested by the two governments in their review of the Convention.

Barrier operations and stream surveys were carried out in Canada as specified in the 1964-65 Memorandum of Agreement. Chemical treatments proposed on Lake Superior were completed except for the Black Sturgeon River which remained at flood levels throughout the year. One of two small streams, not specified in the Agreement, in which lamprey were found, was treated. An investigation of radioactive marking techniques for use on lamprey was not carried out for lack of staff. The Board refunded $31,098 (U.S. dollars), which the Commission applied to the purchase of lampricide.

The program in the United States specified in the Memorandum of Agreement for FY 1964-65 was carried out with only minor changes. In Lake Superior, re-treatment of Sullivans, Little Garlic, and Gratiot Rivers was postponed until there was evidence of transformation of the 1960 year class. The Bad River, which was not scheduled for treatment in FY 1964-65, was found to contain a significant number of survivors from the previous treatment in several tributaries and was treated in early October. Several small streams (Anna, Mud Lake, Reefer, Fish, Smith, Union, Little Iron, and Sand), in which ammocetes were discovered recently, were treated in addition to those mentioned in the Agreement.

In Lake Michigan, three small streams (Deadhorse-Snyder, Hog Island, and Rock) could not be treated because of low flow,

and 1 stream (Crow) because of access. In 3 streams (Cataract, Porter, and McGeach) lamprey had not become re-established and in 3 streams (Bursaw, Marblehead, and Norris) treatments were postponed until the first quarter of FY 1965-66. Seven streams not listed in the Agreement (Ford, Fishdam, Whitefish, Wycamp, Monroe, Pigeon, and Pine) were treated. The Ford treatment had been carried forward from FY 1963-64, while the Whitefish was treated earlier than originally scheduled to eliminate young lamprey surviving the 1962 treatment. The Fishdam, Wycamp, Monroe, Pigeon, and Pine were treated earlier than scheduled because it was convenient to deal with them when nearby streams were being treated.

The Bureau refunded $16,457 at the end of the fiscal year. A portion of this amount ($10,000) was used to support the Economic Study Planning Group and the balance applied to the purchase of lampricide.

The Commission purchased 128,269 pounds of lampricide TFM and 1,060 pounds of the synergist Bayer 73 for its agents in FY 1964-65. The purchase of TFM included 953 pounds of a delivery made by the Hoechst Chemicals Company, Montreal, at the end of FY 1963-64. The rest of the TFM was supplied by the Maumee Chemical Company, Toledo, at $2.68 a pound. It was originally intended to supply 100,000 pounds of TFM to the Bureau of Commercial Fisheries and 30,000 pounds to the Fisheries Research Board. However, the use of synergist in Canadian streams reduced lampricide requirements leaving a reserve sufficient to cover treatments proposed for the next fiscal year. A total of 7,904 pounds of TFM and 560 pounds of Bayer 73 were supplied the Canadian agent and 120,365 pounds of TFM with 500 pounds of Bayer 73 supplied to the United States agent.

Contributions to the FY 1965-66 program. In July, 1964, the Commission approved a program for FY 1965-66 estimated to cost $1,616,600 of which $49,000 was for Administration and General Research and $1,567,600 was for Sea Lamprey Control and Research. The Commission received the first installment payment from the Government of Canada, representing 75 percent of its contribution, on July 2, 1965. On August 27, the Commission was advised that the United States had approved an appropriation which was $49,100 less than the amount requested. After adjustments were made in the Canadian contribution to preserve the cost sharing formula, funds available for Sea Lamprey Control and Research were $1,496,300 and for Administration and General Research were $49,000.

Obligations in FY 1965-66. Agreements were made with the U.S. Bureau of Commercial Fisheries ($783,600) and the

Fisheries Research Board of Canada ($377,466 Canadian dollars) to carry out the sea lamprey program in FY 1965-66. In these contracts the Commission agreed to supply the Bureau with 104,000 pounds and the Board with 18,000 pounds of lampricide. The Board's requirement was partly filled by a purchase from the Maumee Chemical Company of 7,904 pounds using funds expended at the end of FY 1964-65. The remaining amount was filled by delivering 10,000 lbs. from a 60,000 pound order on which the American Hoechst Corporation bid successfully ($2.77 per pound). The balance of this order, which was delivered to the Bureau in the summer of 1965, represented less than half of its requirement as stated in the Memorandum of Agreement. However, the elimination of treatments on the main stems of the Grand and St. Joseph Rivers reduced requirements so that this 50,000 pounds, with the reserve on hand, were sufficient to carry out treatments scheduled for 1966. The balance of the chemical to be purchased in FY 1965-66 (70,000 pounds) will be delivered to the Board.

In making this purchase, the Commission issued a bid invitation on two 70,000 pound amounts, the first to be ordered in October 1965 for delivery to the Board in the spring and early summer of 1966, and the second to be ordered on July 1, 1966 for delivery to the Bureau in the spring of 1967. On the basis of prices offered for the combined amounts, the Commission selected as its supplier the Maumee Chemical Company which quoted $2.58 on 70,000 pounds to be used in Canada and not more than $2.71 on the 70,000 pounds to be used in the United States. The latter price included the estimated cost of licensing from Hoechst, holder of a U.S. patent on the use of TFM as a lampricide.

Obligations for sea lamprey control and research during first half of FY 1965-66 were as follows:

Agreements with agents:			
U.S. Bureau of Commercial Fisheries			$ 783,600
Fisheries Research Board of Canada ($377,466 Canadian)			348,760
			$1,132,360
Economic Study Planning Group			$10,000
Lampricide ordered:			
TFM (Hoechst)	49,568 lbs.	$165,003	
TFM (Maumee)	70,000 lbs.	180,600	
Bayer 73	440 lbs.	2,574	
			348,177
			$1,490,537

Reports and publications. The 1964 Annual Report will be published in January, 1966.

Two technical reports and three papers based on investigations carried out in connection with the sea lamprey control program were as follows:

"Detection and measurement of organic lampricide residues," by Stacy L. Daniels, Lloyd L. Kempe, Thomas J. Billy, and Alfred M. Beeton, Tech. Rep. No. 9, 18 p.

"Experimental control of sea lampreys with electricity on the south shore of Lake Superior, 1953-60," by Alberton L. McLain, Bernard R. Smith, and Harry H. Moore, Tech. Rep. No. 10, 48 p.

"Sex ratios and sexual dimorphism among recently transformed sea lampreys, *Petromyzon marinus* Linnaeus," by Vernon C. Applegate and M. L. H. Thomas, J. Fish. Res. Bd., Canada, 22: 697-711.

"Distribution of fishes in U.S. streams tributary to Lake Superior," by Harry H. Moore and Robert A. Braem, U.S. Fish and Wildlife Service, Special Scientific Report: Fisheries No. 516, 61 p.

"Field application of methods for recovery of the selective lampricide, 3-trifluoromethyl-4-nitrophenol," by T. J. Billy, S. L. Daniels, L. L. Kempe, and A. M. Beeton, Great Lakes Res. Div., Univ. of Mich., Publ. No. 13: 17-24.

Other activities. In September, the Commission moved from the University of Michigan's Natural Resources Building on the Main Campus to the new U.S. Bureau of Commercial Fisheries Research Laboratory, 1451 Green Road, Ann Arbor, Michigan

Auditors Report to Commission

ICERMAN, JOHNSON & HOFFMAN
Certified Public Accountants

303 National Bank
and Trust Bldg.
Ann Arbor, Michigan

September 17, 1965

Great Lakes Fishery Commission
1451 Green Road
P.O. Box 640
Ann Arbor, Michigan

We have examined the statements of receipts and expenditures of the Great Lakes Fishery Commission Administration and General Research Fund, and Lamprey Control Operation Fund for the year ended June 30, 1965. Our examination was made in accordance with generally accepted auditing standards and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying statements of receipts and expenditures present fairly the fund balances of the designated funds of the Great Lakes Fishery Commission at June 30, 1965, arising from cash transactions, and the receipts collected and expenditures made by it during the year then ended, on a basis consistent with that of the preceding year.

/s/ Icerman, Johnson & Hoffman

Great Lakes Fishery Commission

Administration and General Research Fund
Statements of Receipts and Expenditures
Year Ended June 30, 1965

	Actual	*Budget*
Receipts		
Canadian government	$22,813	$22,813
United States government	22,814	22,814
Total receipts	$45,627	$45,627
Expenditures		
Communications	$ 749	$ 800
Equipment	321	500
Insurance, bonding, and audit	351	500
Rents and utilities	732	400
Reproduction and printing	2,209	2,500
Salaries (including F.I.C.A. and pension)	35,528	40,000
Supplies and materials	1,681	1,800
Transportation	12	100
Travel	2,426	2,400
Total expenditures	$44,009	$49,000A
Excess of receipts over expenditures	$ 1,618	
Fund balance, July 1, 1964	3,373	
Fund balance, June 30, 1965	$ 4,991B	

Note A - The total of the beginning fund balance plus the budgeted receipts equals the budgeted expenditures:

Fund balance, July 1, 1964	$ 3,373
Budgeted receipts	45,627
Total available funds	$49,000

Note B - Cash in bank $4,490
Petty cash on hand 1
Fund balance $4,491

Great Lakes Fishery Commission

Lamprey Control Operation Fund

Statement of Receipts and Expenditures

Year Ended June 30, 1965

	Actual	*Budget*
Receipts		
Canadian government	$ 451,611	$ 450,602
United States government	1,001,945	1,002,954
Total receipts	$1,453,556	$1,453,556
Expenditures		
United States Fish and Wildlife Service	$ 775,793	$ 792,250
Canadian Department of Fisheries	316,613	341,300
Lampricide purchases	347,446	324,710
Economic Study Planning Group*	3,882	-0-
Wisconsin Alumni Research Foundation	5,000	-0-
Obligated for unpaid commitments of 1964-65:		
Economic Study Planning Group*	6,118	-0-
Total expenditures	$1,454,852	$1,458,260A
Excess of expenditures over receipts	$ 1,296	
Fund balance, July 1, 1964	4,704	
Fund balance, June 30, 1965	$ 3,408	

Note A - The total of the beginning fund balance plus the budgeted receipts equals the budgeted expenditures:

Fund balance, July 1, 1964	$ 4,704
Budgeted receipts	1,453,556
Total available funds	$1,458,260

*Additional expenses of $4,675 for Economic Study Planning Group raised its total expenditures to $8,557, leaving a balance of $1,443 unexpended in obligated funds. Total fund balance for the fiscal year thereby increased to $4,851.

Fisheries Research Board of Canada

Financial Report to Great Lakes Fishery Commission

April 1, 1964 to March 31, 1965.

Administration in field		
(43% of costs of London Headquarters)	($113,332.00)	$ 48,733.00
Operations		
Operation and Maintenance of Electric Barriers		69,512.00
Chemical Control (Lampricide)		155,226.00
Stream Surveys		42,365.00
		$267,103.00
Contributions to Superannuation		
(6-1/2% of permanent salaries)	($ 95,068.00)	6,179.00
		$322,015.00
Contract Administration		
(6% of Total Disbursements)		19,321.00
	(Canadian)	$341,336.00

Funds provided by Commission

Payments under 1964-65 Contract	$374,922.00
Cost applicable to 1964-65	341,336.00
Unexpended Balance returned to Commission	$ 33,586.00

Bureau of Commerical Fisheries
Sea Lamprey Control and Research Program

Report of Expenditures for All Activities
July 1, 1964 through June 30, 1965.

	Funds Programmed	Salaries	Expenses	Total	Unobligated Balance
Program costs					
Ann Arbor, Michigan Laboratory					
Chemical Operations	$487,000	$353,869	$117,543	$471,412	$15,588
Barrier Operations	137,750	99,773	37,121	136,894	856
Research	104,000	76,948	26,903	103,851	149
	$728,750	$530,590	$181,567	$712,157	$16,593*
Washington, D.C.	$ 24,000	$ 23,383	$ 66	$ 23,449	$ 551
General Administration and Executive Direction					
Ann Arbor, Michigan	$ 39,500	$ 39,500	-	$ 39,500	-
Totals	$792,250	$593,473	$181,633	$775,106	$17,144

*Includes refund of $16,457 to Commission.

Bureau of Commerical Fisheries
Sea Lamprey Control and Research Program

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Totals	$792,250	$593,473	$181,633	$775,106	$17,144

*Includes refund of $16,457 to Commission.

LAMPREY CONTROL AND RESEARCH

The responsibility for advising the Commission on the progress and plans for sea lamprey control was assigned to a Sea Lamprey Control and Research Committee in 1965. The Committee met during the Annual Meeting of the Commission in Ann Arbor on June 22-24, and considered:

a. reports of the Commission's agents on sea lamprey control and research during 1964* and progress during the spring of 1965;+

b. information on incidence of lamprey wounds and survival of lake trout in various areas of Lake Superior;

c. revisions in program of sea lamprey control and research in fiscal year 1965-66 to meet reduction in funds requested;

d. program of sea lamprey control and research proposed for fiscal year 1966-67.

The Committee gave special attention to a report prepared by the Bureau of Commercial Fisheries on possible sources of residual lamprey in Lake Superior, the use of less expensive methods of assessing lamprey abundance than electrical barriers, and the desirability of extending stream treatments to Lake Huron in the summer of 1966.

The Committee noted the striking differences in the results experienced in using the synergist Bayer 73 in the United States and Canada and recommended that technicians of the Commission's two agents compare and evaluate procedures and techniques. The Committee also recommended that the Canadian agent study possible sources of continuing lamprey recruitment and review the need for annual treatment of Batchawana Bay streams.

After discussing various changes in the lamprey program costs in fiscal year 1965-66 the Committee recommended that surveys in Canada be reduced, that no barriers be operated on the east shore of Lake Michigan and west shore of Lake Huron (except on the Ocqueoc River), and that purchases of lampricide be reduced since requirements would not be as high as first anticipated. The Committee submitted to the Commision a program for fiscal year 1966-67 which included extension of chemical treatments to Lake Huron.

*Annual Report of Commission for 1964.
+Included in final reports for 1965 on pages 28 and 46.

LAMPREY CONTROL AND RESEARCH IN THE UNITED STATES

by

Bernard R. Smith

Bureau of Commercial Fisheries
U. S. Fish and Wildlife Service

Progress in sea lamprey control was exceptionally good in 1965. Chemical treatment of scheduled Lake Superior streams was completed in October and only the 5 southernmost streams of Lake Michigan remain to be treated. Forty streams discharging 4,127 cfs of water were treated with 74,885 pounds of the lampricide (Table 1).

Table 1. Summary of chemical treatments in United States waters of the Great Lakes in 1965.

	Number of streams	Discharge at mouth (cfs)	Stream miles treated	Lampricide (pounds)	Synergist (pounds)
Superior	16[1]	888	214	12,042	...
Michigan	24[2]	3,239	860	62,843	295
Total	40	4,127	1,074	74,885	295

[1]Includes 15 re-treatments
[2]Includes 9 re-treatments

The number of spawning-run sea lampreys taken at barriers on U.S. streams of Lake Superior remained stable for the third consecutive year, 11,834 in 1965 compared to 11,766 in 1964 and 10,852 in 1963. The Brule River again accounted for more than half (52 percent) of this total. The tagging program has been intensified to attempt to find the source of the lampreys at the barriers.

A most significant advance in knowledge of sea lamprey life history came with the capture of the first adult-phase lampreys from the known-age group in the Garlic River. The minimum age to transformation of the population in this stream is 5 years, and it has been demonstrated that sea lamprey larvae do not all metamorphose on reaching this age.

Lake Superior surveys

Thirty Lake Superior tributaries were surveyed in preparation for chemical treatment or to monitor the re-established populations. Intensive surveys on 5 of these streams, Betsy, Two Hearted, Sucker, Huron, and Brule Rivers, to evaluate magnitude and distribution of sea lampreys, occupied a large part of a field season shortened a month by adverse spring weather. Re-established populations were found in 17 streams, small numbers of residual ammocetes in 10, and no sea lamprey larvae were found in 11 tributaries.

Resurveys of 22 streams considered marginal for sea lamprey production revealed 2 with ammocetes. One ammocete, 87 millimeters in length, was found in the Cranberry River, Bayfield County, Wisconsin, and 8 young-of-the-year larvae were recovered from the Gooseberry River, Lake County, Minnesota. Neither of these streams will contribute significantly to the adult population. Sea lamprey nests were observed in 13 of 25 streams examined for evidence of adult spawning. Minnesota tributaries demonstrated a continued decline of spawning activity with less than 30 nests counted in the 12 streams surveyed. No nests or adults were found in the Split Rock River where 82 and 43 nests were found in 1963 and 1964, respectively. Forty-four nests were counted in 3 areas of the Bad River where 189 nests were located in 1964.

Post-treatment surveys were completed on 20 streams. Small residual populations of lampreys occurred in the Garlic River, Marquette County, Michigan; the Bad River, Ashland County, Wisconsin; and the Sand River, Bayfield County, Wisconsin.

Lake Superior chemical treatments

Chemical treatment of United States tributaries of Lake Superior began in May and continued until the end of October. Generally good treatment conditions existed and problems were few. Sixteen streams with a total discharge of 888 cfs were treated (Table 2). All were re-treatments except the Gratiot River, Keweenaw County, Michigan, which had been reserved as a study stream. Four streams scheduled for treatment during the 1965 field season were not treated. Sullivans Creek, Alger County, Michigan, is a study stream where treatment will be postponed until there is some indication of transformation of ammocetes. Three Mile Creek, Luce County, and Miners River and Five Mile Creek, Alger County, Michigan, contained no sea lamprey larvae. Three Mile and Five Mile Creeks are marginal

Table 2. Details on the application of lampricide to tributaries of Lake Superior in 1965.

Stream	Date	Discharge at mouth (cfs)	Concentration (ppm)		TFM (pounds)
			Minimum effective	Maximum allowable	
Anna River	May 18	50	4.0	8.0	594
Mud Lake Inlet	May 26	8	0.5	2.5	54
Little Gratiot River	May 26	100	1.0	3.0	576
Brule River	July 11	210	2.0	4.0	3,510
Two Hearted River	July 30	130	2.5	6.0	2,448
Little Two Hearted River	Aug. 1	32	2.0	5.0	630
Little Garlic River	Aug. 11	5	2.5	7.0	252
Harlow Creek	Aug. 11	10	2.0	5.0	144
Betsy River	Aug. 27	67	2.5	4.0	918
Sucker River	Aug. 29	140	4.0	7.0	1,386
Beaver Lake Outlet	Sept. 8	3	3.0	8.0	144
Furnace Creek	Sept. 22	21	3.0	7.0	144
Garlic River	Sept. 29	18	3.0	5.5	252
Buck Bay Creek[1]	Oct. 6	15	2.0	8.0	180
Huron River	Oct. 20	65	1.0	4.0	702
Gratiot River[2]	Oct. 21	14	3.0	7.0	108
Total	...	888	...	...	12,042

[1]Au Train River tributary treated to keep ammocetes from reaching Au Train Lake.
[2]Initial treatment.

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Total	...	888	...	...	12,042

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sea lamprey producers at best and the absence of ammocetes was not unexpected. Miners River, however, is not a marginal producer, and the absence of sea lamprey ammocetes may be attributed to the electric barrier near the mouth. These streams will be examined periodically and re-treated when necessary.

The Huron River was not scheduled for treatment until the fall of 1966. However, an intensive survey prompted by the relatively large barrier catch uncovered a small residual and a larger re-established population of larvae. The stream was treated to eliminate the residual population and to estimate the size of the ammocete population present. A known number (3,444) of American brook lampreys was introduced before chemical treatment. These lampreys served as marked individuals since the species does not occur in the Huron River. Collection following treatment of 1,627 sea lamprey ammocetes, 38 newly transformed adult sea lampreys, and 271 American brook lampreys provided the basis for a population estimate of 25,000 sea lamprey ammocetes.

The Brule River, Douglas County, Wisconsin, was re-treated in 1965 to eliminate the recently discovered sea lamprey population above the upstream limits of the 1962 treatment, to check the source of the 88 young adult sea lampreys captured in fyke nets in the fall of 1964, and to see if the population could be the source of the large 1964 and 1965 spawning runs. Surveys made during and after the re-treatment indicated a relatively small ammocete population and it is believed that the large spawning run in the Brule River is due to its location at the west end of Lake Superior in an area lacking other good lamprey spawning streams.

Ammocete collections during chemical treatment continued to demonstrate a decrease in sea lamprey ammocete abundance in most streams. Relatively large re-established populations were found in the lower Brule River, the lower Huron River, and the lower third of the Little Garlic River. A residual ammocete population was discovered in the vicinity of the upper Garlic River's alluvial fan in Sauxhead Lake. An attempt to eliminate this population was made by spraying the area and adjacent waters with chemical during the stream treatment. Four hundred and forty-eight sea lamprey ammocetes were collected within 50 yards of the alluvial fan. No ammocetes were collected beyond this area, indicating that this small ammocete population was localized. This area will be re-treated in the next field season to measure the success of the supplemental treatment.

A fish kill of approximately 14,000 white suckers occurred

during the Brule River treatment. No significant fish kills were noted in other streams.

Lake Michigan surveys

Surveys were completed on 17 streams scheduled for treatment along the east shore of Lake Michigan. Intensive effort on the main channels of 2 of the larger rivers, the Kalamazoo, Allegan County, and the Grand, Ottawa County, yielded no larval lampreys. High water temperatures and pollution may be limiting factors in these areas. Lamprey larvae were present in several tributaries to the main streams.

Post-treatment surveys were completed on 20 streams and residual populations of sea lampreys were located in 3. The White River, Muskegon County, produced 3 larvae, while the Ogontz and Whitefish in Delta County produced 15 and 32, respectively.

Lake Michigan chemical treatments

Chemical treatments began in mid-April and ended in late October. Water levels generally were higher than those in the previous 2 years. Twenty-four streams with a total discharge of 3,239 cfs were treated with chemical (Table 3). Fifteen streams received initial treatments. The Whitefish River in Delta County was re-treated after only 2 years because of the presence of numerous residual sea lampreys. Collections during treatment substantiated the presence of ammocetes throughout the watershed and also showed that a strong 1964 year class was present. The many tributaries, springs, beaver dams, and extensive ground water seepage have reduced the effectiveness of treatments in this river. Post-treatment surveys indicate a general, but reduced, distribution of residual sea lampreys after the second treatment.

Surveys of the Grand River, St. Joseph River, and Kalamazoo River main channels failed to demonstrate the presence of sea lampreys. All 6 infested tributaries of the Grand River were treated successfully. Four of the 5 infested tributaries to the St. Joseph River were treated successfully. The remaining tributary will be treated in 1966. In tributaries of both rivers, sea lamprey larvae were absent from the areas of confluence with the main stream. Considering the size of these streams, sea lamprey populations were very small. Apparently lampreys in the Grand and St. Joseph Rivers can be controlled by treatment of the infested tributaries.

Use of the synergistic mixture containing 98 percent by

Table 3. Details on the application of lampricide to tributaries of Lake Michigan in 1965.

Stream	Date	Discharge at mouth (cfs)	Concentration (ppm)		Lampricide (pounds)
			Minimum effective	Maximum allowable	
Stoney Creek[1]	April 20	69	5.0	14.0	1,008
White River[1]	May 3	725	4.0	10.0	15,174
Jordan River	May 12	276	5.0	17.0	6,660
Loeb Creek	May 15	6	6.0	17.0	144
Monroe Creek[1]	May 15	10	6.0	17.0	144
Wycamp Creek[1]	May 18	33	4.0	10.0	378
Big Sucker River	May 18	20	4.0	14.0	252
Carp Lake River[1]	May 26	77	2.0	5.0	828
Millicoquins River	May 30	30	3.0	9.0	558
Whitefish River	June 3	363	5.0	13.0	11,034
Little Fishdam River[1]	June 22	15	2.5	8.0	414
Ogontz River	June 24	16	2.0	5.0	207
Big Fishdam River	June 25	50	3.0	8.0	630
Norris Creek[1]	Aug. 11	7	2.0	8.0	90
Grand River[1]	Aug. 19	158	6.0	25.0	4,760
Kalamazoo River[1]	Sept. 10	1,063	4.0	10.0	12,610[2]
Gibson Creek[1]	Sept. 13	2	7.0	20.0	18
Allegan 3 Creek[1]	Sept. 13	1	7.0	20.0	9
Allegan 4 Creek[1]	Sept. 13	1	6.0	18.0	9
Bursaw Creek	Sept. 14	4	7.0	11.0	270
Marblehead Creek	Sept. 14	2	11.0	21.0	90
Brandywine Creek[1]	Sept. 27	10	3.0	10.0	93
Black River[1]	Oct. 6	204	7.0	18.0	4,624
St. Joseph River[1]	Oct. 16	97	11.0	29.0	3,134
Total	...	3,239	...	...	63,138[2]

[1]Initial treatment.
[2]Includes 295 pounds of synergist.

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[2]Includes 295 pounds of synergist.

weight of TFM and 2 percent 5,2'-dichloro-4'-nitrosalicylanilide (TFM-2B) was limited to the Kalamazoo River. Although the concentration of TFM-2B was maintained at no more than 2.0 ppm above the minimum concentration of 4.0 ppm, a substantial fish mortality occurred in the main stream. Fish species previously unaffected (gizzard shad, alewife, and longnose gar) were found dead as were large numbers of carp, channel catfish, suckers, and northern pike. Low dissolved oxygen which ranged from 0.6 ppm at the application point to 2.4 ppm at the mouth may have been a factor.

Water quality of southern streams is affecting adversely the biological activity of TFM. Minimum concentrations of 10.0 to 12.0 ppm of TFM are required and little improvement is expected throughout the year. Moreover, most streams south of Muskegon, Michigan are polluted to some degree with industrial wastes which appear to reduce selectivity of TFM. Low dissolved oxygen levels also complicate the situation.

Lake Erie and Ontario surveys

A reconnaissance along the United States shores of Lakes Erie and Ontario in April provided information for planning a more intense stream survey later. Two Lake Ontario tributaries in the vicinity of Watertown, New York, were shocked on the spring trip, and sea lamprey larvae found in the Little Salmon River.

Stream surveys to determine the presence or absence of sea lampreys were initiated on eastern Lake Erie tributaries in September. Four of the 120 streams examined between Conneaut, Ohio, and Buffalo, New York, contained young sea lampreys. Only one stream, Raccoon Creek, produced an appreciable number of individuals, and these were confined to the lower few miles of stream. Conneaut Creek, Crooked Creek, and Cattaragus Creek supported very small populations of ammocetes or transforming adults. Sea lamprey production appears possible in approximately 15 more Lake Erie tributaries in this area, and further work will be required to determine their status. Heavy pollution, small or intermittent stream flows, and other adverse factors render the remaining area streams unsuitable for sea lampreys.

Electric barrier operations

Electric barriers were operated between April 10 and July 13 on 16 streams along the south shore of Lake Superior. A late spring and unseasonably cold weather delayed the installation

of the barriers about 2 weeks. A total of 11,834 adult sea lampreys was taken during the period of operation (Table 4). This number is 68 more than in 1964, 982 more than in 1963, but 54,866 less than in 1961 for the same streams. The catch is 77 percent below the 5-year average, 1957-61, before control measures became effective.

The run developed slowly. The first peak (13.6 percent of the total run) appeared between May 26 and 30, and the second peak of 10 days' duration occurred between June 5 and 14 (25.1 percent). The run declined slowly through late June and early July; the last week of operation produced 441 sea lampreys, or 3.7 percent of the run.

The number of sea lampreys from the 11 barriers east of the Keweenaw Peninsula increased 11 percent compared to 1964, while the catch from the western streams decreased 6 percent. The greatest contribution continued to come from the Brule River which produced 52 percent of the barrier catch. However, the run in the Brule River declined 8 percent when compared with the previous year. Increased numbers were taken at 9 barriers. The barriers on the Two Hearted River and the Brule River were the only ones to capture more than 1,000 adults.

Index barriers were operated on 6 streams tributary to Lake Michigan. The 3 barriers on streams tributary to northern Green Bay began operating on April 12-13 and were closed down July 2. The sea lamprey run was delayed by unseasonably cold weather and no lampreys were captured until the first week of May. During the period May 26-30, 27.2 percent of the total catch was taken. The 3 barriers captured 3,277 adult sea lampreys. The catch from these barriers has declined 75 percent since 1961 when 12,886 adults were captured. Two new barriers on the Lincoln and Pentwater Rivers, tributaries to the east shore of Lake Michigan, captured 401 lampreys. The catch from the Pere Marquette River dropped to 311 adult sea lampreys compared to 678 in 1964.

The number of spawning sea lampreys entering the Ocqueoc River, Lake Huron, declined significantly. The Ocqueoc River weir captured 1,390 adults compared to 2,677 in 1964, and 4,674 in 1963.

Data collected from 10 Lake Superior index streams indicate an increase in the size of sexually mature sea lampreys. The average length and weight of the sea lampreys sampled were 16.9 inches and 5.7 ounces as compared to 16.6 inches and 5.4 ounces in 1964. As a group, these are the largest sea lampreys taken at the Lake Superior barriers since 1959. The

Table 4. Catches of adult sea lampreys for comparable periods from 16 Lake Superior streams and 3 Lake Michigan streams, 1960-1965.

Stream	1960	1961	1962	1963	1964	1965
Lake Superior						
Betsy River	696	1,366	316	444	272	187
Two Hearted River	4,290	7,498	1,757	2,447	1,425	1,265
Sucker River	4,683	3,209	474	698	386	529
Miners River	399	220	64	107	74	23
Furnace Creek	2,211	1,012	132	142	93	199
Rock River	2,598	3,660	399	353	229	237
Chocolay River	4,173	4,201	423	358	445	563
Iron River	317	2,430	1,161	110	178	283
Huron River	1,237	4,825	70	201	363	637
Silver River	1,271	5,051	267	760	592	847
Sturgeon River	161	427	397	1,437	375	135
Misery River	696	962	80	24	12	3
Firesteel River	250	1,118	70	178	327	11
Brule River	9,539	22,478	2,026	3,414	6,718	6,163
Middle River	2,815	3,502	311	48	45	52
Amnicon River	1,094	4,741	879	131	232	700
TOTAL	36,430	66,700	8,826	10,852	11,766	11,834
Percentage change		83.1	-86.7	22.9	8.4	0.6
Lake Michigan						
Sturgeon River	910	2,378	1,650	751	823	512
Bark River	1,065	1,085	710	298	202	189
Cedar River	4,676	9,423	5,729	6,412	3,568	2,576
TOTAL	6,651	12,886	8,089	7,461	4,593	3,277
Percentage change		93.7	-37.2	-7.8	-38.4	-28.6

percentage of males entering Lake Superior tributaries continued its downward trend. The 1965 catch contained 52.0 percent males as compared to 54.8 percent in 1964 and 67.1 percent in 1963. This is the lowest percentage of males recorded since 1953.

Adult sea lampreys from the Bark River, a tributary to northern Green Bay, averaged 15.4 inches in length and 4.1 ounces in weight. These are the smallest sea lampreys recorded for this river. Males comprised 58.1 percent of the total number of sea lampreys sampled from the Bark River. This is a significant reduction in the preponderance of males which formed 70.3 percent in 1964.

The average length and weight of sea lampreys from the Pere Marquette River, a tributary to the east shore of Lake Michigan, were 16.3 inches and 5.1 ounces as compared to 15.7 inches and 4.3 ounces in 1964. Males comprised 49.8 percent of the total number of sea lampreys sampled.

Migrant rainbow trout and longnose suckers on 9 representative streams of Lake Superior increased in 1965. A total of 1,319 large rainbow trout was recorded compared to 809 in 1964. The number of white suckers, however, reached a low for the 7-year period.

Sea lamprey wounds were found on 3.2 percent of the rainbow trout entering 9 Lake Superior tributaries. This was a decline of 0.2 percent from 1964, but still 0.5 percent above the number bearing wounds in 1963. At the barrier on the Pere Marquette River (east shore Lake Michigan), 17.0 percent of the rainbow trout captured bore sea lamprey wounds compared with 9.5 percent in 1964.

Movement of tagged sea lampreys in the Great Lakes

The tagging study to provide information on the parasitic phase of the sea lamprey and to determine the degree of interchange among the Great Lakes was continued in the fall of 1965. The tagging operation was expanded to include not only the St. Mary's River, but certain ports on Lakes Superior, Michigan and Huron. The expansion was made possible through the cooperation of the Fisheries Research Board of Canada, the conservation departments of Wisconsin and Minnesota, and many commercial fishermen.

A total of 1,745 sea lampreys was tagged and released between August 19 and December 31, 1965. By December 31, 135 tagged sea lampreys had been recovered, most of them from near the area of release. The following recoveries, however,

are significant: 4 adults tagged at Sault Ste. Marie were captured in Lake Superior; 3 tagged near Detour (Lake Huron) were recovered at Sault Ste. Marie; and an adult tagged at St. Ignace was caught off Brevort (Lake Michigan).

The average length of the sea lampreys varied widely in different areas. Lampreys from the St. Marys River at Sault Ste. Marie were the largest. They averaged 17.7 inches (range 11.5 to 25.0 inches) in length, while those taken near Detour were the smallest, with a mean length of 12.8 inches (range 8.9 to 19.7 inches). Sea lampreys from Port Dolomite averaged 13.8 inches, St. Ignace 14.4 inches, and Cheboygan 13.3 inches. For comparison, sea lampreys captured at the Lake Superior barriers in 1965 averaged 16.9 inches in length.

Of the 403 sea lampreys tagged below the navigational locks in the St. Marys River in the fall of 1964, 14 have been recovered. One was taken at the Chocolay River barrier on June 21, 1965, 1 was captured near Gros Cap in Lake Superior, and the other 12 were scattered throughout Lake Huron. Most significant, however, is the recovery of 2 of the tagged individuals in Lake Huron almost a year after tagging. These individuals apparently failed to mature sexually and provide the first indication that the duration of parasitic life in the wild may exceed the commonly accepted period of 12 to 18 months.

Fyke net operations

Fishing of fyke nets in tributary streams to monitor the downstream movements of transforming and larval lampreys was continued in the fall of 1965. Consolidation of weir zones and the increased work load prevented fishing of the nets in the spring. Four newly metamorphosed adults were captured this year in fyke nets which have been fished systematically in 8 Lake Superior streams since 1961. Multiple treatment of these streams has reduced the number of young parasitic-phase sea lampreys taken in fyke nets by 94 percent. Nets fished in Furnace Creek captured 3 transforming sea lampreys and 1 was captured in the Chocolay River.

Nets fished systematically in 5 tributaries of northern Green Bay, Lake Michigan, captured 58 young adults. This is a reduction of over 97 percent from the numbers caught in these streams before chemical treatment. Nets fished in 2 streams (the Sturgeon River net took 44 and the Whitefish River net captured 10) accounted for 93 percent of the total.

Fyke nets were fished in several other streams and locations to assess their effectiveness in providing abundance data

and to provide additional information on movement of juvenile sea lampreys within a river system. A total of 13 young adults was captured this year from 3 tributaries of the upper Whitefish River, which enters Green Bay, compared to 146 in 1964. This stream was treated for the second time in 1965. Nets fished in the Brule River (Lake Superior) below a chain of lakes captured 83 individuals in 1964; however, after chemical treatment in 1965, only 2 transforming sea lampreys were caught. Sixty-two newly metamorphosed individuals were captured below Otter Lake in the Sturgeon River (Lake Superior) in 1965, compared to 93 in 1964. Nets fished above Otter Lake took 15 young adults.

Fyke net fishing in 6 streams along the east coast of Lake Michigan was repeated this year. The White River, which received its first chemical treatment in 1965, produced only 1 recently metamorphosed adult compared to 43 individuals in 1964. The remaining 5 rivers were treated prior to the initiation of the fyke net operation. Of these, the North Branch of the Pentwater River produced 6 young adults compared to 2 in 1964; however, the nets were fished for 28 days more than in 1964. In addition, 2 sea lampreys were caught in the Muskegon River.

Recently transformed sea lampreys were again collected from a mechanical screen on the water intake of an industrial plant on the Pere Marquette River. These collections illustrate a drastically reduced production of young adults following treatment of the river with larvicide. Prior to the chemical treatment, 19,793 individuals were taken during the 1963-64 downstream migration. After treatment in May, 1964, only 75 sea lampreys were collected during the downstream migration in 1964-65.

Since the fall of 1962, the Ocqueoc River, Presque Isle County, Michigan, has been fished continuously with fyke nets to study the downstream migrations of sea lampreys. The downstream migration of recently transformed lampreys in the Ocqueoc River starts in October or early November. The migration reaches a peak when stream temperatures drop to between 40° and 44° F in mid-November and continues at a high level until just before freeze-up, in December or early January. The spring migration reaches a peak during the spring breakup. It slackens when water levels begin to drop and is essentially over when water temperature reaches 46° to 48° F. All downstream migration in the Ocqueoc River is over by the middle of May.

The fall migration in 1965 was much larger than in 1964.

In 1964, 960 young adult sea lampreys were captured between the first of November and the last of December in a net which has been fished in the same manner each year. During the same period of 1965, 2,883 individuals were taken in this net.

An attempt has been made to measure the production of transformed lampreys from the Ocqueoc River. A portion of each year's downstream migration was marked with insoluble sulfide dye injection and periodic releases were made above the fyke netting site. A total of 1,320 marked transformers was released in 1963-64, 300 in 1964-65, and 1,200 during the first half of the 1965-66 migration. The ratio of marked to unmarked individuals captured provided a basis for an estimate of production. Extremely high water during the spring peak in 1964-65 prevented a population estimate. The 1963-64 estimate of 42,000 and the 1965-66 estimate of 44,000 for the first half of the run indicate the enormous productive potential of this single river and provide a basis for measuring the effects of chemical treatment.

Re-establishment in treated streams

Seven streams under special study to determine minimum age for transformation have been reduced to 3 by chemical treatments. The treated streams were the Little Garlic and Gratiot Rivers, tributary to Lake Superior, and Marblehead and Bursaw Creeks, tributary to Lake Michigan. All 4 streams contained sea lamprey ammocetes of the 1960 year class but transforming sea lampreys were recovered in 1965 from only 3. Although the growth rate of the Gratiot River ammocetes appears to approximate the growth in the other 3 streams, no transformation was evident. These observations suggest that in most Lake Superior tributaries sea lampreys begin to metamorphose in 5 years. Ammocetes in the 7 study streams, however, have not shown the rapid rate of growth found in some of the large Lake Superior tributaries such as the Bad, Sturgeon, and Ontonagon Rivers. Frequent re-treatments were necessary in these streams to eliminate residual populations. Consequently, information necessary to indicate the minimum time to transformation could not be obtained. The possibility of metamorphosis occurring in less than 5 years in streams where ammocetes demonstrate rapid growth should not be overlooked.

The 3 remaining study streams containing ammocetes of the 1960 year class are Snyder-Deadhorse and Hog Island Creeks, tributary to Lake Michigan, and Sullivans Creek, tributary to Lake Superior. Growth rates of sea lamprey larvae in these

streams are significantly slower than in the 4 treated streams. During 1965, very few larvae more than 120 millimeters in length were recovered from each creek, and there was no evidence of transformation. Continued monitoring of these streams should provide information on the potential of small streams to produce adult sea lampreys.

The reduction in the number of streams with re-established populations and the relative abundance of sea lamprey ammocetes has paralleled the decline of adults taken in the electric barriers. The collection of young-of-the-year larvae this year was hampered by bad weather and unfavorable stream conditions, but it appears that low recruitment will continue. In Lake Superior tributaries, the 1960 and 1961 year classes are now found only in Sullivans Creek. The 1962 year class is found in 6 streams including Sullivans Creek. The 1963 and 1964 year classes are found in 12 and 17 streams, respectively. The 1965 year class has been found in 13 streams in a preliminary survey.

Lake-dwelling ammocete populations

Concern as to the significance of lake-dwelling larvae prompted further work in Lake Superior. Tows with an electric trawl totaling 28 hours were made at 15 locations and sea lamprey ammocetes captured in Furnace Bay, Huron Bay, and off the mouths of the Little Garlic and Brule Rivers.

The trawl captured 7 sea lamprey and 34 native ammocetes in Furnace Bay. The rate of capture for sea lampreys was only 2.2 individuals per 100 minutes of towing time compared to 13.0 in 1964, 17.2 in 1963, and 15.4 in 1962. Eight larvae were taken off the mouth of the Little Garlic River during 209 minutes of towing time. The shallow inshore waters off the mouth of the Brule River produced 8 sea lamprey and 2 native ammocetes in 145 minutes. A series of tows in water 80 to 110 feet deep, however, was unproductive. Tows cannot be used effectively below 110 feet. The deepwater tows produced a large number of *Mysis relicta*. Only 1 sea lamprey ammocete and 49 native ammocetes were captured in Huron Bay in 95 minutes of towing time. The relatively small population of sea lampreys in Huron Bay as indicated by the electric trawl was verified by an extensive search for ammocetes in shallow waters with shocking equipment. Several hours of collecting produced 238 native and 3 sea lamprey ammocetes.

Further trawling was done in Otter Lake in an effort to locate the source of newly metamorphosed adults taken in the fall of 1964 by fyke nets in the Sturgeon River below the lake. The

trawl took only 4 native ammocetes in 197 minutes of towing time. Hand shocking for 3 hours in shallow water using power from electrical equipment on the trawl boat produced 1 sea lamprey and 16 native ammocetes. The sea lamprey was taken in the Sturgeon River at the outlet of the lake.

Trawling in Lake Michigan waters was limited to 2 areas. Trawling for 110 minutes near the mouth of the Ford River resulted in the capture of 1 sea lamprey ammocete. Extensive trawling in the lower 15 miles of the Grand River was negative.

Sea Lamprey research

The dominant research activity continues to be the development of less costly and more effective larvicides. Studies of the factors which have limited the usefulness of the synergistic mixture TFM-2B in tributaries of Lakes Michigan and Huron, and clearer definition of the toxicity of this compound have received major emphasis. A limited amount of work on salicylanilides, other than Bayer 73, also has been continued. "Rough screening" of new compounds has been curtailed.

Development of larvicides. Fish kills with TFM-2B in the relatively hard-water streams tributary to Lake Michigan prompted a study designed to elaborate, as completely as possible, the toxicity of the mixture and its component chemicals in waters from streams of all the upper Great Lakes. Bioassays were run with TFM, TFM-2B, and Bayer 73 in waters from 13 sources. Assays with these materials were conducted simultaneously in a single sample of water from each source to permit direct comparison of results. Increasing water hardness (calcium carbonate content), which is known to reduce the biological activity of TFM was shown to have a similar effect on TFM-2B and Bayer 73. In addition, each water sample was analyzed for conductivity, pH, calcium, chlorides, copper, ferric iron, ferrous iron, ammonia nitrogen, nitrate, nitrite, sulfate, silica, tannin and lignin, ortho phosphate, meta phosphate, and dissolved carbon dioxide. None of these measurements correlated better with toxicity than water hardness.

The toxicity data obtained for larval lampreys and rainbow trout with TFM-2B, TFM, and Bayer 73 in each of the 13 test waters again indicated a considerable amount of synergism when Bayer 73 and TFM compounds were mixed. Only in very soft or hard waters did the concentration of either compound alone produce significant lamprey mortality. In 7 of the 13 water

sources the expected rainbow trout mortality with Bayer 73 was greater than observed with the mixture. In these waters, it would appear that mixing with TFM reduced the toxicity of Bayer 73 to rainbow trout. In the remaining 6 waters, the combined expected mortality for the 2 chemicals used separately was less than the mortality observed with the mixture. Mixing the 2 compounds, therefore, had a synergistic effect on their toxicity to rainbow trout. The different behavior of the mixture could not be related to the chemical and physical conditions.

Additional bioassays were conducted with TFM and Bayer 73 to investigate more thoroughly their relative toxicity. These assays were with Lake Huron water and mixtures containing from 1 to 10 percent Bayer 73. Each of the mixtures indicated a high level of synergism in toxicity toward larval lampreys. The level was greatest at 2 and 3 percent since the combined expected mortality figures were the lowest with these mixtures. The depressant effect of TFM on the toxicity of Bayer 73 to rainbow trout was pronounced in mixtures from 2 to 10 percent. In all except the 1 to 10 percent mixtures the amount of Bayer 73 was sufficient to produce over 90 percent mortality even though the mixtures themselves killed only 25 percent of the rainbow trout. Why the toxic effect of Bayer 73 should be less when it is mixed with TFM is difficult to explain without detailed knowledge of the physiological action of the compounds.

Although the toxicity values themselves did not indicate the reason the TFM-2B mixture should be difficult to use under field conditions, the series of regression lines which were derived with various mixtures provide some insight to the problem. These lines are extremely steep (slope functions 1.2 ± 0.1) and parallel. Therefore, small fluctuations in the percentage composition of the mixture drastically affect the toxicity. As an example, the data obtained in Lake Huron water indicate that 6.95 ppm of TFM-2B (2.0 percent Bayer 73) will produce a mortality of 25 percent among rainbow trout. If a mixture containing 2.5 percent Bayer 73 was applied at the 6.95 ppm level, the expected mortality among trout would be 70 percent. Fluctuations of 0.5 percent or more in the Bayer 73 component are difficult to prevent with present methods of application.

Screening of new chemical compounds. Screening of previously untested compounds has been reduced during the past year. A total of 126 chemicals was tested for the first time in 1965. Sixty-one were nontoxic to larval lampreys at the initial screening level of 10.0 ppm. Among the compounds toxic to larval

lampreys, 37 were active at concentrations from 10.0 to 1.0 ppm, 26 from 1.0 to 0.1 ppm, and 2 from 0.1 to 0.01 ppm. Twenty-six chemicals indicated some degree of selective toxicity toward larval lampreys.

Larval growth and transformation. For a number of years, experiments have been underway to evaluate the effect of supplemental feeding on ammocetes held in aquaria. Results from these experiments consistently have indicated poor survival, growth, and almost no transformation among larvae held in only Lake Huron water. In those groups receiving supplemental feeding, survival, growth, and transformation have been near that expected in the better lamprey-producing streams. While the results obtained can not be considered as conclusive, they do indicate that the food resources available to larvae in Lake Huron may not be sufficient to permit survival.

Experimental population of ammocetes. The experimental population of known-age ammocetes established in the Garlic River in 1960 produced its first adult-phase sea lampreys. During the year, 4 young adults were captured at the downstream trap. Two had been captured as ammocetes, marked, and released in the study area.

A total of 733 ammocetes was collected and examined during October for annual growth information. None of the ammocetes showed signs of metamorphosis. The capture of 4 recently metamorphosed juveniles and data provided by the October collection established the minimum duration of larval life for this population at 5 years, and proved that metamorphosis for all individuals in a single age group did not occur at the same age, but would continue over a period of years. The rate of growth for the past year and the range in lengths for the ammocetes were comparable to 1963 and 1964 (Table 5). The ammocetes had a mean length of 107 millimeters and ranged from 65 to 176 millimeters. The recently transformed adults

Table 5. Growth of 1960 year class of ammocetes in the Garlic River to October, 1965.

Year	Mean length	Length range	Length increment
1960	13 mm	10- 19 mm	13 mm
1961	39 mm	25- 54 mm	26 mm
1962	63 mm	37-107 mm	24 mm
1963	80 mm	52-134 mm	17 mm
1964	94 mm	43-159 mm	14 mm
1965	107 mm	65-176 mm	13 mm

were 152, 155, 161, and 172 millimeters long. Only 2 percent of the ammocetes in the October 1964 collection were as large or larger.

The downstream trap captured 4,340 lampreys in 1965 compared to 2,847 in 1964, 370 in 1963, and 9 in 1962. The period of major downstream drift for ammocetes was from April through June.

Since October 1962, 5,642 ammocetes have been marked and returned to the study area. Only 16 marked individuals, including the 2 recently metamorphosed adults, were taken at the trap during the year. The annual October collection made with an electric shocker, however, contained 143 marked individuals. Three were marked in 1962, 4 in 1963, 31 in 1964, and 106 were from the 1965 group. One ammocete had been marked twice.

LAMPREY CONTROL EXPERIMENT IN CANADA

by

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Fisheries Research Board of Canada

The following report is based on a program conducted by the Fisheries Research Board of Canada at its Biological Station located in London, Ontario until September, 1965 and for the remainder of the year from the newly established Sea Lamprey Control Experiment Station at Sault Ste. Marie, Ontario.

Lamprey barrier operations

Electrical barriers were operated on the Big Carp, Harmony, Chippewa, Batchawana, Sable, Pancake, Pays Plat, and Big Gravel Rivers tributary to the Canadian side of Lake Superior to assess the relative size of the spawning population of sea lampreys. These barriers have been functioning "as a unit" since 1960 and are part of a larger network started in 1954 to control lampreys. The 8 barriers have been operated in the same way during May, June, and July since 1956, and it is assumed that the number of lampreys collected at the barriers each year will be roughly proportionate to the total spawning population and will, therefore, serve as an indication of lamprey abundance.

In 1965, it was impossible to operate the Pancake barrier until June 9 because of a legal dispute over access. This delay makes it difficult to compare lamprey recoveries with previous years' collections. Table 1 lists the lamprey collected at 8 barriers to July 31 for the years 1956 to 1965. Although the 1965 total of 573 lampreys is less than previous years, it is considered that if the Pancake River barrier had been functioning earlier, the 1965 figures would be comparable with those of 1964. Fewer lampreys have been collected from the Canadian barriers than United States barriers. However, both indicate the same increase in the lamprey population to 1961 and the same reduction and stabilization of the population since 1962. The lamprey population in Lake Superior as reflected in counts at the assessment barriers has been approximately 20 percent of the population from 1956 to 1961. The 80 percent reduction is attributed to treatment of Lake Superior streams with lampricide.

During the fall of 1964, barriers were constructed on three of the eleven selected tributaries of Lake Huron—the Root and

Table 1. Number of upstream migrant, adult sea lampreys collected annually at electrical barriers on 8 Canadian tributaries to Lake Superior during the period May 15 to July 31, for the years 1956 to 1965.

Stream	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Sault Ste. Marie Area										
Big Carp	23	23	11	15	20	6	5	2	1	15
Harmony	22	15	6	7	19	14	3	0	4	5
Chippewa	825	353	171	290	1045	453	123	222	274	114
Batchawana	382	408	301	467	626	561	136	336	216	140
Sable	58	63	36	138	241	88	10	36	5	17
Pancake	657	1051	750	804	1286	931	187	387	257	94
Sub-total	1967	1913	1275	1721	3237	2053	464	983	757	385
Nipigon Area										
Pays Plat	4	3	4	30	10	31	9	9	5	0
Big Gravel	8	101	152	537	626	799	315	64	52	188
Sub-total	12	104	156	567	636	830	324	73	57	188
TOTAL	1979	2017	1431	2288	3873	2883	788	1056	814	573

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Garden Rivers near Sault Ste. Marie, and the Harris-Naiscoot combination on the east shore of Georgian Bay. During the early spring of 1965, the Still River barrier was built and operating by May 21. At the end of the barrier operating season, electrical barriers were constructed on the Echo River, a tributary to Echo Lake near Sault Ste. Marie; the Two Tree River on St. Joseph Island in the St. Mary's River; the Mad River, a tributary to the Nottawasaga River near Camp Borden; and the Bayfield River, a tributary to the main body of Lake Huron south of Goderich. Table 2 lists the number of lamprey collected at the Root and Garden Rivers to July 31 and the Harris-Naiscoot and Still Rivers to July 15, 1965. The reason for the low runs in the Root and Garden Rivers, which have been heavily used by spawning lamprey in the past, has not been determined.

Table 2. Number of upstream migrant, adult sea lampreys collected at electrical barriers on four Canadian tributaries to Lake Huron during the period May 19 to July 31, 1965.

Stream	No. of lamprey collected	Barrier turned on	Barrier turned off	First lamprey collected	Last lamprey collected
		Sault Ste. Marie Area			
Root	16	May 19	July 31	June 9	July 30
Garden	35	June 3	July 31	June 4	July 31
		Georgian Bay Area			
Harris-Naiscoot	593	April 27	July 15	May 3	July 8
Still	344	May 21	July 15	May 21	July 12
TOTAL	988				

Surveys

Thirty-seven Lake Superior tributaries were surveyed in 1965 and no sea lamprey were located. Twenty-six of these streams between Agawa Bay and Marathon are, for the most part, accessible only by boat. Surveys using the lampricide TFM were also performed in the Batchawana Bay and Pancake Bay areas in conjunction with the annual stream treatments of the Batchawana, Chippewa and Sable Rivers in an attempt to determine the extent of lamprey populations in the estuaries of numerous small streams and drainage ditches peculiar to the area. It has been known for some time that sea lamprey ammocoetes inhabit these estuarine areas and it is thought that they are migrants from the bay population and are not produced

in these streams. Sea lamprey were collected in limited areas in the estuaries of six streams in Batchawana Bay and one in Pancake Bay. Post-treatment surveys conducted on the Kaministikwia, McIntyre, Jackfish, and Cypress Rivers produced no sea lamprey ammocetes.

Surveys from 1956 to 1958 located 38 lamprey-producing streams on the Canadian shore of Lake Huron. No new streams have been found among the 229 re-examined since 1963 (27 in 1965).

Surveys to determine the number and location of Lake Ontario streams harbouring sea lamprey populations were initiated in 1963 and completed in 1965. Fifty-two streams tributary to the St. Lawrence River, from Brockville to the Ontario-Quebec border, were checked in 1965. The absence of sea lamprey in these streams can be attributed, in part, to the relative scarcity of good spawning conditions. Twenty-five tributaries checked were dry or drying up and only five streams of the 52 examined in April had flows of five cfs or more. The largest estimated flow was 25 cfs. The Trent Canal and its tributaries from Lake Ontario to Rice Lake, representing some 50 miles of waterway, were surveyed. Sea lamprey were found only in Mayhew Creek, which is located below the first lock approximately one mile upstream from Lake Ontario. These preliminary surveys suggest that the complex system of locks and dams (five series of locks in the first nine miles of canal) has blocked migrant spawning sea lamprey. A re-survey of 30 selected streams from Niagara to Kingston in 1965 found no new sea lamprey populations.

In summary, only 22 of the 363 streams in Canada tributary to Lake Ontario and the upper St. Lawrence River have been found to harbour sea lamprey populations.

Bio-assays

To facilitate planning and budgeting for future expansion into the lower Great Lakes, bio-assays were performed on 24 selected streams on Lake Ontario, 6 on Lake Erie, 2 on Lake St. Clair, and 13 on Lake Huron. Laboratory and field tests demonstrate that use of the synergist "Bayer 73" with the lampricide TFM will result in a substantial saving (up to 50 percent).

Chemical treatments

Conditions on the Canadian side of Lake Superior in 1965 were the worst encountered since stream treatments began in 1958. Heavy rains, high water, continuous flooding, and cold

inclement weather were general during the spring and autumn seasons. Even in midsummer, rivers were treated at high flows.

During the 1965 season, six streams tributary to the Canadian side of Lake Superior were treated with the lampricide TFM (Table 3). It was impossible because of flooding to treat

Table 3. Canadian streams treated with lampricide, Lake Superior, 1965.

		Flow (cfs)	Stream miles treated	TFM (pounds)	Synergist (pounds)	Ammocoete abundance
Batchawana	July 8-10	375	8.5	3,124	76	Scarce
Chippewa	July 12-13	270	6	1,530	32	Scarce
Pancake	July 15-17,22	102	17	654	-	Moderate
Sable	July 19-21	28	6	228	-	Scarce
Big Pic	Aug. 19-Sept. 1	450	101	7,367	153	Nil
Michipicoten	Sept. 19-20	2,450	12	11,513	230	Moderate
TOTAL		3,675	150.5	24,416	491	

Cash Creek, Black Sturgeon and White Rivers which were specified in the Memorandum of Agreement. The Black Sturgeon, has been used extensively for logging operations and it has never been possible to control water levels earlier than mid-September. The logging operations were to have been curtailed in 1964 but were continued for another year. In 1965, the company's operations went longer than anticipated, running into mid-October, and high water conditions thereafter precluded any possibility of treatment. Similar circumstances prevailed in the White River. Although logging operations were terminated in the summer, the equipment used for manipulating the stoplogs in the dam at the outlet of White Lake was broken and could not be repaired in time for lampricide treatment in the fall. A minimum stream discharge of about 800 cfs during the summer and early fall required that the dam be functional for treatment purposes.

Electric trawling

Trawling was carried on in four inland lakes in the Thessalon River watershed of Lake Huron where there is a resident population of sea lamprey. No ammocetes were collected. Trawling operations were also continued in Batchawana Bay and Pancake Bay along the shoreline off the estuarine areas of small streams and drainage ditches where limited numbers of sea

lamprey ammocetes had been located. One sea lamprey ammocete was collected off the mouth of Black Creek in Batchawana Bay and one off Westman's Creek in Pancake Bay. The greatest percentage of sea lamprey ammocetes were collected near the mouths of lamprey-producing streams in Batchawana Bay.

Lamprey tagging

Early in October, trawling was begun in the St. Mary's River below the locks at Sault Ste. Marie to collect adult sea lamprey for tagging. The procedure, comparable to that employed by the U.S. Bureau of Commercial Fisheries, was to tow a modified beam trawl behind a small boat in the propeller wash of the outboard motor.

Four differently designed boats with various types of trawls were used—a pontoon boat with a large working platform, a small 15-foot aluminum skiff, a 16-foot aluminum cabin cruiser, and finally an 18-foot aluminum boat outfitted with twin 28 h.p. outboard motors. The latter outfished the others and caused less damage to lamprey collected.

From October 18, 1965 to April 28, 1966, the United States and Canadian crews tagged and released 825 lamprey in the St. Mary's River. Thirty-four were recaptured by the end of April 1966— 5 in Lake Superior, 13 in the lower St. Mary's River, and 16 in Lake Huron.

Establishment of station at Sault Ste. Marie, Ontario.

Early in May 1965, arrangements were finalized for consolidation of the sea lamprey work of the Fisheries Research Board of Canada at Sault Ste. Marie, Ontario. Plans for construction of a new office building and transfer of headquarters for the Sea Lamprey Control Experiment in Canada from the London Biological Station to Sault Ste. Marie were announced at the Annual Meeting of the Great Lakes Fishery Commission in June 1965. Plans for office accommodation were drafted in June and construction started in July. Personnel were transferred from London in August and September and temporary headquarters at Sault Ste. Marie were established. Early in October, secretarial staff was hired locally and an administrative officer transferred from the London Station. The staff moved into the partially completed building in mid-November and by November 24 the building was completed and accepted by the Department of Public Works. It is located on land leased from the St. Lawrence Seaway Authority on St. Mary's Island immediately below the Canadian locks.

MANAGEMENT AND RESEARCH

The responsibility of advising the Commission on the status and problems of the sport and commercial fisheries, the progress and adequacy of investigations, and measures to improve the productivity of these fisheries was assigned to the Management and Research Committee. At its first meeting held at the time of the Commission's Annual Meeting on June 22-24, the Committee reviewed its responsibilities and organization and recommended that its membership be enlarged to include one federal representative from each country.

Recent information on lake trout stocks in Lake Superior was considered and it was noted that although the present level of fishing provided sufficient data to follow biological changes it did not provide sufficient statistical data to study recruitment and mortality. Development of such information to allow efficient harvest of the stocks on a sustained basis was urgently needed. The Committee, therefore, recommended that the Commission relax its earlier recommendation, which limited fishing effort to that required to support biological research, in order to allow additional fishing on certain discrete populations to measure their response to increased fishing pressure.

The initiation of lake trout plantings in Lake Michigan in 1965 required the immediate development of studies to assess the success of rehabilitation, and to determine to what extent fisheries for other species would effect the recovery of lake trout. The Lake Michigan Committee was asked to give immediate attention to the development of studies to evaluate the recovery of lake trout and to coordinate investigations of cooperating agencies.

The Management and Research Committee received reports from the U.S. Bureau of Commercial Fisheries on the status of new fisheries for abundant species and some of the biological, technological, and economic factors influencing their development. The trawl fishery of Lake Michigan and its future potential were discussed as well as problems and research associated with the development of new techniques for processing and preserving fish. Market development and consumer education programs of the Bureau were described.

The Committee noted that the lake committees had already begun to function as a clearing house for exchange of information on the introduction of new species. Agencies agreed that detailed studies would precede the introduction of new species to determine their desirability. Reports of these studies would be considered by all lake committees.

Lake trout rehabilitation

The program of lake trout rehabilitation carried out jointly by state, provincial, and federal agencies in the United States and Canada was continued in Lake Superior and extended to Lake Michigan in 1965.

A total of slightly less than 2.0 million lake trout were planted in Lake Superior in 1965 (Table 1), a decrease of about 685,000 fish from plantings in 1964 because of a diversion of fish to Lake Michigan. Of the Lake Superior total, 468,000 were planted in Ontario waters, 780,000 in Michigan waters, 447,500 in Wisconsin waters, and 251,200 in Minnesota waters. Plantings in 1965 brought the total number of lake trout planted in Lake Superior since 1958 to 12.8 million.

Plantings totalling nearly 1.3 million trout in Lake Michigan marked the first step to rehabilitate the trout fisheries in this lake (Table 2). Over 1.0 million were planted in Michigan waters and 205,000 in Wisconsin waters.

Commercial fishing for lake trout was restricted in Lake Superior for the fourth consecutive year to encourage the recovery of the trout. Some fishing with commercial gear was permitted, however, to provide information on lake trout comparable to that taken previously in order to follow the recovery and evaluate the effect of plantings. In the United States, a limited number of commercial fishermen operating under contract or special permits took 45,800 trout weighing about 130,000 pounds. In Canada, the fishery operated under a 150,000 pound quota applied by season and area. By the end of the year, the Canadian catch totalled 104,200 pounds of which 92 percent (36,500 fish weighing 96,000 pounds) were examined.

The incidence of lamprey-wounded lake trout in the fall catches fell to a record low in 1965 indicating a further decline in lamprey abundance throughout the lake. Wounding rates in September were 1.6 percent in Ontario and Michigan waters and only 0.2 percent in Wisconsin waters.

Generally speaking, improvement in the availability of lake trout during the past several years was sustained in 1965, except locally. Numbers of marketable trout caught per 10,000 feet of gill net lifted during the spring in inshore waters rose from 111 in 1964 to 135 in 1965 in Wisconsin and from 43 to 55 in Michigan. In Ontario, catch per effort values remained virtually the same (56 in 1964 and 54 in 1965), and limited data from Minnesota indicated a minor decline from 68 to 50.

Table 1. Plantings of hatchery-reared lake trout in Lake Superior, 1965 (yearlings except as noted).

Agency	Location planted	Number	Fin clip
Ontario Department of Lands and Forests	Marathon	83,000	dorsal and right pectoral
	Outer Black Bay	84,600	left pectoral and right ventral
	Nipigon Bay	75,000	dorsal and left pectoral
	Eastern Lake Superior	225,000	right pectoral and left ventral
Bureau of Sport Fisheries and Wildlife	Keweenaw Bay-Grand Marais Michigan	487,000	left ventral
	Lower Whitefish Bay	99,700	right ventral
	Ontonogan	193,400	both ventrals
Wisconsin Conservation Department	Apostle Islands	347,500	adipose
	Gull Island Shoal	100,000	left pectoral
Minnesota Department of Conservation	Split Rock River to Grand Marais, Minnesota	101,700	adipose and both ventrals
	Knife River to Beaver Bay	149,500[1]	right pectoral
TOTAL		1,946,400	

[1]fingerlings

Table 2. Plantings of hatchery-reared lake trout in Lake Michigan, 1965.

Agency	Location planted	Number	Fin clip
Bureau of Sport Fisheries and Wildlife	Seul Choix Pt. to Epoufette	867,000	left ventral
	Grand Traverse Bay	100,500	right ventral
	Kewaunee (Wisconsin)	101,600	adipose
Wisconsin Conservation Department	Northport (Gills Rock)	103,000	adipose
Michigan Department of Conservation	Beaver-Fox Islands area	102,000	dorsal
TOTAL		1,274,100	

The improvement in the survival of lake trout in inshore waters has resulted in a general increase of mature trout. Large trout, (25 inches and over) in Wisconsin waters were 40 percent more abundant than in preceding years, and the abundance of mature females in September (13 per 1,000 feet) was more than double that for 1964. The catch per effort of spawning lake trout in the Apostle Island region in 1964 and 1965 was 9 times greater than in 1963 and over 100 times greater than in 1960. The capture by research vessels of 80 young-of-the-year from the 1964 spawning indicates that successful natural reproduction has resumed on an encouraging scale in Wisconsin waters. Elsewhere in the lake, evidence of significant natural spawning in inshore waters was lacking although mature fish had been encountered the previous fall.

Hatchery-reared trout completely dominated the catches in inshore waters, comprising over 85 percent of legal-sized trout and about 98 percent of the undersized trout. Trout from early plantings are maturing and appearing on spawning grounds in greater numbers each year.

Further evidence of the healthy condition of lake trout populations on offshore grounds was obtained. Catch per unit effort values ranging from 173 to 510 fish per 10,000 feet of net lifted in United States waters and 189 to 467 fish in Canadian waters were substantially higher than any encountered on inshore grounds. Less than 1.5 percent of the trout from most offshore areas were of hatchery origin. Adequate numbers of juvenile fish and increasing abundance of large mature trout were again encountered on offshore grounds supporting the opinion that these populations are self-reproducing and capable of supporting moderate exploitation.

Organization meetings of lake committees

Lake Superior.—At its organizational meeting in Milwaukee, Wisconsin on March 4, 1965, the Lake Superior Committee elected Mr. D. J. Curry, (Michigan), Chairman and Mr. G. C. Armstrong (Ontario), Secretary. The Committee, which assumed the responsibilities of the Lake Trout Rehabilitation Committee on Lake Superior, reviewed action taken by this committee and approved its recommendations.

General procedures for dealing with changes in regulations were considered and it was agreed that all regulations pertaining to stocks of common concern would be brought to the attention of the Commission. Although uniformity of regulations was desirable, it was realized that complete uniformity could not be expected and in many cases could not be justified biologically. All agencies would, therefore, seek agreement on regulations by advising others of the changes proposed and the reasons, and consider comments of other agencies concerned before taking action.

Lake Michigan.—The Lake Michigan Committee was also organized at a meeting in Milwaukee, Wisconsin on March 4, 1965. Mr. George E. Sprecher (Wisconsin) was elected Chairman and Mr. Woodrow Fleming (Indiana) Secretary. Here again the Committee endorsed the action taken by the Lake Trout Rehabilitation Committee on lake trout plantings and assessment on Lake Michigan and adopted procedures for dealing with changes in regulations similar to those proposed by the Lake Superior Committee.

Michigan reviewed its proposal to introduce coho salmon to two streams tributary to Lake Michigan (Platte River and Bear Creek). Plans called for plantings of approximately 700,000 smolt to begin in March, 1966. Since the parent stock of these salmon spawned when 3 years old, plantings of about this size would be continued for at least 2 additional years until all 3 age classes were represented in the population. A prospectus "Coho salmon for the Great Lakes" would be prepared by Michigan and distributed to Great Lakes fishery agencies. Information collected by Michigan on the life history of striped bass and problems of introducing this species into Lake Michigan were discussed.

Lake Ontario.—The Lake Ontario Committee was established at a meeting in Watertown, New York on April 28-29, 1965 by re-organizing the existing Lake Ontario Fish Management Committee on a formal basis and extending its terms of reference to ensure that all matters referred to it by the Commission would be fully dealt with. Mr. G. C. Armstrong (Ontario), was elected Chairman.

Reports on the status of important commercial species indicated an increase in the commercial production of white perch and a further decline in the production of whitefish and walleye. The increased catch of white perch resulted from favorable markets rather than an increase in abundance of the species which apparently reached its peak several years ago. Experimental trawling operations indicated that smelt and possibly whitefish could be taken in commercial quantities by trawl gear from some areas. Investigations involving creel census and tagging of walleye and bass were carried out in eastern Lake Ontario, the Bay of Quinte, and the St. Lawrence River. Angling

success in the St. Lawrence River area was reasonably good in New York waters, but relatively poor in Canadian waters.

A program of land acquisition and development to provide fishermen, hunters, and recreational boaters access to public waters was described by New York. The added facilities were expected to result in better distribution of fishing pressure on heavily used waters.

New York reported the establishment of a research station at Cape Vincent which would be developed along the lines of the Glenora Fisheries Station in Ontario. The station would be used to investigate boundary waters and problems in inland waters of concern to the State.

The Great Lakes Institute, University of Toronto, reported that the research vessel *Porte Dauphine* would monitor 62 stations in Lake Ontario during the next five years for information on oxygen, temperature, alkalinity, and water hardness. Studies would continue on evaporation rates and similar physical phenomena and the detection of pollutants in low concentrations and their use in plotting water mass movements. Phytoplankton and primary productivity studies were to be undertaken and the use of oligochaete fauna as indicators of environmental conditions explored.

Lake Erie.—The Lake Erie Committee was established at a meeting in Sandusky, Ohio on June 3, 1965. This was accomplished by reorganizing the Lake Erie Fish Management Committee on a formal basis and establishing terms or reference that would enable the Committee to deal fully with matters referred to it by the Commission. Mr. J. W. Lockwood of Ontario was elected Chairman. It was agreed that the fishery problems of Lake St. Clair would be the responsibility of the Lake Erie Committee.

Recent physical and chemical changes in Lake Erie and Lake St. Clair and modification of plankton and bottom fauna were described and reports on the status of walleye, yellow perch, and smelt were reviewed.

Proposed changes in regulations were presented by several agencies and the reasons discussed. A joint review of regulations pertaining to muskellunge in Lake St. Clair by Michigan and Ontario had resulted in the establishment of virtually uniform regulations on size limits, closed seasons, and bag limits. Trawling for smelt in Ontario waters was now under formal licence. Limited trawling for white bass was being allowed in Ontario under special permits.

Members of the Committee were requested to prepare a statement for consideration at the next meeting which would set out objectives for the fishery in their jurisdiction and indicate the kinds of investigations required to develop the information needed for the application of additional measures to improve the fishery. An early consideration of the walleye problem in Lake Erie and the development of measures to restore the fishery for this species was urgently needed.

SCIENTIFIC ADVISORY COMMITTEE

The formation of new committees to help plan and coordinate fishery research and management on the Great Lakes has modified to some extent the role of the Scientific Advisory Committee which was established when the Commission was organized. The Committee met during the Annual Meeting and after discussing its functions suggested that it could contribute more effectively if it were to take part in the formulation of programs and not merely in their review. It also believed that in addition to providing the Commission with its opinions on specific questions it could advise the Commission on problems that might become important. The Committee also reported to the Commission at the meeting on sea lamprey control and research, lake trout rehabilitation, and the introduction of exotic species.

Sea lamprey control and research. The Scientific Advisory Committee discussed the need for assessment barriers in 1966 and 1967. The Committee insisted on the necessity for the barrier network on Lake Superior as a basis for assessing the full effects of the program although it recognized that they provided only partially reliable quantitative measurements on lamprey abundance. The development of a less expensive method of following changes in abundance would be difficult because of the lack of a historical base for comparison.

The stability of lamprey in Lake Superior at approximately 20 percent of former abundance and the effect of this level on trout populations were discussed. The Committee believed that it was not possible now to determine whether additional effort was required to reduce the lamprey population further since the full effects of the second round of treatments had not been fully expressed.

Lake trout rehabilitation. The Committee discussed the possibility that the numbers of lake trout planted in various areas of Lake Superior were just sufficient to feed the residual lamprey population, provide biological samples, and leave enough fish to maintain a self-reproducing population. In these circumstances, a further reduction in the present level of sea lamprey predation must be made before the lake trout planting program could be reduced. Eventually, a significant fishery would have to be allowed on Lake Superior in order to fully evaluate the effects of the lamprey control and lake trout restoration programs.

The Committee considered the reports presented to the Management and Research Committee and felt that although information on inshore stocks was limited, it could, generally, support the contention that some of these were as discrete as offshore stocks. Dense populations among these inshore stocks, particularly in Wisconsin waters, might be fished more heavily as an experiment. However, such action might reduce dispersion of lake trout to other areas.

It was suggested that differences in abundance of lake trout observed in inshore waters of Lake Superior had resulted from the uneven distribution of planted fish. The Committee recommended that stocking of lake trout in Lake Superior be directed to areas of low density. The possibility of using fish proposed for Lake Michigan to increase planting in Lake Superior was considered, but it was felt that production from the Jordan River Hatchery would provide adequate plantings in both lakes.

Introduction of exotics. The Scientific Advisory Committee discussed the introduction of exotic species into Great Lakes waters and suggested that the most promising area for this type of management would be Lake Erie, where the changing environment had resulted in the disappearance of the more desirable native species. Introduced species would also face environmental changes and it was suggested that the Committee might meet with representatives of agencies now studying Lake Erie water quality in order to obtain a general understanding of future conditions.

The Committee felt that with any introduced species, it was necessary to consider such items as catchability (i.e., proportion harvestable), survival, availability at various times of the life cycle, and degree it could be controlled. Three species mentioned as possible introductions into the Great Lakes were kokanee, silver salmon, and striped bass. The Province of Ontario had concluded from information on kokanee in western lakes that there was a vacant niche for this fish in the Great Lakes. After discussing possible competition between alewives and kokanee, both plankton feeders, it was concluded that any competition between these two species in which kokanee dominated would be all to the good. On the introduction of striped bass, it was felt that Great Lakes rivers lack sufficient length for successful spawning and that this would be a particularly serious problem in Lake Erie. It was also thought that the low temperature would limit their success in the upper Great Lakes. The Committee believed the striped bass should be considered for introduction into Lake Erie, but not into the Upper Great Lakes.